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RECEIVER

(Jushin-ki)

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SPECIFICATION

Title of the Invention

Receiver

Claims

A receiver, which is characterized by the fact that when a first broadcast wave is received from a composite signal containing a second broadcast wave and a third broadcast wave adjacent thereto with the first broadcast wave to be received as center,

the above composite signal is frequency-converted so that the carrier frequency of the above first broadcast wave becomes a first frequency and the above composite signal is frequency-converted so that the above carrier frequency becomes a second and a third frequencies just as the above composite signal distributes in both-side bands with the first frequency as center,

the conversion frequencies are so selected as to relatively deviate by only twice as much as an interoffice frequency to the above first frequency, and only the above first broadcast wave

[1] Numbers in margin indicate pagination in foreign text.

is obtained by synthesizing these frequency-converted composite signals.

Detailed Description of the Invention

For example, when channels adjacent to a receiving channel exist in AM broadcast, they become a frequency spectrum relation as shown in Fig. 1. Namely, when a second and a third broadcast waves S_A, S_C exist on both side of a broadcast wave to be received (called the first broadcast wave) S_B, they have occupied zones)Y ()Y = 7.5 Hz) of side wave band components, therefore the side wave band components superimpose as illustrated, accordingly, if an adjacent channel is a large electric power station, a so-called adjacent-channel disturbance occurs.

The present invention proposes a receiver which can surely eliminate such an adjacent-channel disturbance. The receiver based on the present invention will be illustrated in detail by reference to drawings below and is a case suited to an AM receiver in this example.

In Fig. 2, **1** is a high-frequency amplifier, **2** is a medium-frequency amplifier, **3** is a synchronous detector consisting of i. e., a multiplizer and gives an AM detector output to a terminal **4**.

In the present invention, when a first broadcast wave S_B is received from a composite signal S_O containing a second broadcast wave and a third broadcast wave S_A, S_C adjacent thereto with the first broadcast wave to be received S_B as center,

the above composite signal is frequency-converted so that the car-

/2

rier frequency f_b of the above first broadcast wave S_B becomes a first frequency, e. g., a medium-frequency f_i, and the above composite signal S_O is frequency-converted so that the above carrier frequency f_b becomes a second and a third frequencies f_a, f_c just as the above composite signal S_O distributes in both-side bands with the first frequency f_i as center,

the conversion frequencies are so selected as to relatively deviate by twice as much as an interoffice frequency)I to the above first frequency f_i. Then, these frequency-converted composite signals S_{OM}, S_{OL}, S_{OH} are synthesized, consequently, the phases of said converted composite signals S_{OM}, S_{OL}, S_{OH} are selected so that only the first broadcast wave can be received among them.

The first to third frequency converters **10M**, **10L** and **10H** are provided to obtain these converted composite signals in the present invention. Their constitutions is illustrated in due order while seeing Fig. 3, and the first frequency converter **10M**

is provided to obtain the first converted composite signal S_{OM} as shown in Fig. 3A.

This converter **10M** is constructed by one mixer, and an output S_1 obtained by a local oscillator **5** is fed with the broadcast wave S_B to be received. In this case, the output of said high-frequency amplifier **1** is not a single broadcast wave in the presence of adjacent channels and contains the second and the third broadcast wave beginning with the first broadcast wave S_B. Namely, it is a composite signal S_0, but only the first broadcast wave S_B is shown for the convenience in the drawing. If such a signal is fed to the converter **10M** and the carrier frequency f_b in the first broadcast wave to be received S_B is converted to the first frequency, as shown in Fig. 3A, the entire composite signal S_0 is frequency-converted to this converted composite signal S_{OM}. In this example, the first frequency is selected as the medium frequency f_b. Therefore, the first converted composite signal S_{OM} is taken as the first medium-frequency signal.

Moreover, this Fig. 3 only shows carriers in respective broadcast waves. Then, the horizontal axis is shown by the angular frequency ω for convenience. Therefore, ω_a - ω_c are taken as angular frequencies of carriers in the first - third broadcast wave S_A - S_0, and ω_i is taken as an angular frequency

relating to the medium frequency f_i. Then,)ω corresponds to an angular frequency of an interoffice frequency f_w (10 kHz).

In the present invention, the second and third frequency converters **10L** and **10H** are thus provided to form the second and third conversion frequencies S_{OL}, S_{OH} as the first conversion frequency S_{OM} is formed. In this case, as shown in Fig. 3, the frequency conversion is so conducted that the angular frequency ω_b of carrier in the first broadcast wave S_B only deviates by 2)ω in the relation among the three. It is illustrated from the second frequency converter **10L**.

The second frequency converter **10L** is constructed by the first and the second mixers **11A**, **11B**, and a signal made into a frequency relationship as described below is fed to the first mixer **11A**. Namely, a first oscillator **12** oscillating a frequency twice as much as the medium frequency f_b and a second oscillator **13** oscillating a frequency twice as much as the interoffice frequency f_w are provided, respectively, the first oscillation output is fed to a mixer **14** with the local oscillation output S_1. After the difference frequency f_1, i. e., the difference angular frequency ω_1 is formed, the second oscillation output in which the angular frequency obtained by the second oscillator **13** is made to 2)ω is fed to the first mixer **11A**.

If the difference angular frequency in the angular frequency obtained by mixing is taken as ω_2, and only this frequency component is fed to the second mixer **11B**. The composite signal S_O containing the first broadcast wave S_B is fed to the second mixer **11B**, therefore the sum angular frequency ω_3 in the frequency-mixed component is used as the second converted composite signal S_{OL}. The angular frequencies ω_1 – ω_3 are as follows, respectively.

$\omega_1 = 2\ \omega_i - \omega_1$ JJ (1)

$\omega_2 = \omega_1 - 2\ )\omega = 2\ \omega_i - \omega_1 - 2\ )\omega$ JJ (2)

$\omega_3 = \omega_2 + \omega_b = \omega_i - 2\ )\omega$ JJ (3)

As is evident from Eq. **3**, the angular frequency after the conversion of the first broadcast wave S_B becomes $(\omega_i - 2\ )\omega)$ in the second converted composite signal S_{OL}, and a frequency interval of the first and second converted composite signals becomes $2\ )\omega$.

This second converted composite signal S_{OL} is frequency-converted so that the third broadcast wave S_C exists on the low-pass side and the second broadcast wave S_A exists on the high-pass side.

In the third frequency converter **10H**, the frequency conver-

/3

sion is conducted so that the angular frequency after the conversion of the first broadcast S_B becomes $(\omega_i + 2\ )\omega)$, but the third frequency converter **10H** can be similarly constructed as the second frequency converter **10L** because it can be made by the same procedure as that for obtaining the second converted composite signal S_{OL}. Accordingly, its description is omitted. Therefore, **15A**, **15B** show the first and the second mixers. The relationships of angular frequencies are as shown below.

$$\omega_4 = \omega_1 + 2\ )\omega = 2\ \omega_i - \omega_1 + 2\ )\omega \qquad \text{JJ} \qquad (4)$$

$$\omega_5 = \omega_4 + \omega_b = \omega_i + 2\ )\omega \qquad \text{JJ} \qquad (5)$$

Accordingly, as shown in Fig. C, the third converted composite signal S_{OH} in which the third broadcast wave S_C is converted on the low-pass side and the second broadcast wave S_A is converted on the high-pass side is obtained.

Here, frequency components of the converted first to third converted composite signals are examined. Now, the first to the third broadcast wave S_A - S_C are expressed as follows.

$$S_A(t) = a(1 + f_a(t))\sin \omega_a t \qquad \text{JJ} \qquad (6)$$

$$S_B(t) = b(1 + f_b(t))\sin \omega_b t \qquad \text{JJ} \qquad (7)$$

$$S_C(t) = c(1 + f_c(t))\sin \omega_c t \qquad \text{JJ} \qquad (8)$$

a-c: amplitudes

$f_a(t)$-$f_c(t)$: modulation (information) signal

Accordingly, since the composite signal S_O which should be output by the high-frequency amplifier **1** is a synthesized output of the first – third broadcast waves, i. e. since

$$S_O(t) = a(1 + f_a(t))\sin \omega_a t + b(1 + f_b(t))\sin \omega_b t + c(1 + f_c(t))\sin \omega_c t \quad \text{JJ} \quad (9),$$

the first to third converted composite signals S_{OM} - S_{OH} become as follows. However, components other than necessary ones are omitted.

$$S_{OM}(t) = A\cos(\omega_i +)\omega)t + B\cos \omega_i t + C\cos(\omega_i -)\omega)t \quad \text{JJ} \quad (10)$$

$$S_{OL}(t) = A\cos((\omega_i + 3)\omega)t + \theta_L) + B\cos((\omega_i - 2)\omega)t + \theta_L) + C\cos((\omega_i -)\omega)t + \theta_L) \quad \text{JJ} \quad (11)$$

$$S_{OH}(t) = A\cos((\omega_i +)\omega)t + \theta_H) + B\cos((\omega_i + 2)\omega)t + \theta_H) + C\cos((\omega_i + 3)\omega)t + \theta_H) \quad \text{JJ} \quad (12)$$

here,

$A = a(1 + f_a(t))$

$B = b(1 + f_b(t))$

$C = c(1 + f_c(t))$, and

θ_L: the phase difference of carriers of the first broadcast wave S_{AT} in the first and second converted composite signal S_{OM}, S_{OL} from each other

θ_H: the phase difference of carriers of the third broadcast wave S_{CT} in the first and third converted composite signal S_{OM}, S_{OH} from each other

Accordingly, if $\theta_L = \theta_H = 0$ is taken now and S_{OL} and S_{OH} are added to S_{OM} in reverse phase, only the desired first broadcast wave S_A is finally received as Fig. 3D because the second and third converted broadcast waves S_{AT}, S_{CT} in the first converted composite signal S_{OM} are offset each other. Therefore, if an output S_O' ($=S_A$) of a synthesis circuit **16** is fed to the synchronizer **3** via the medium-frequency amplifier **2**, the first broad-cast wave S_A can be AM detected without any adjacent-channel disturbance.

In order to eliminate these broadcast wave S_A, S_C, which should eliminate the disturbance of adjacent channels, the phase difference θ_L, θ_H of carriers from each other in the respective

broadcast waves S_A, S_C fed to the synthesis circuit **16** must be zeroed. Therefore, their control circuits are provided in the present invention. Because control circuits **20L**, **20H** for zeroing the phase differences θ_L, θ_H, take the same constitution respectively, the constitution and actions of one control circuit **20L** are illustrated in this example.

The control circuit **20L** has a bandpass filter **21L** and feeds a first converted composite signal S_{CM} thereto, in this case, only a carrier whose angular frequency becomes $(\omega_i -)\omega)$, i. e., only the carrier of said first broadcast wave S_{AT} is extracted, then the second converted composite signal S_{OL} is 90° phase shifted and fed to a phase comparator **23L** constructed, e. g., by a multiplizer to phase compare carriers of the two converted signal S_{OL}, S_{AT} with each other. A DC output obtained by feeding the comparison output to a low-pass filter (not specially illu-

/4

strated) is fed as its control signal to a phase adjusting circuit **24L** provided on a signal transmission path between the oscillator **13** and the first frequency converter **10L**.

If such a control loop is constructed, the phase of the interoffice frequency f_w is continued to be controlled until θ_L = 0, therefore the phase difference can be zeroed. Moreover, **22L** represents a phase-shifting circuit of 90°.

The phase adjustment in this phase adjusting circuit **24L** is similarly corrected as before so that, e. g., zero crossing points (0°, 180° or 90°, 270°)) of one signal and zero crossing points of the other signal are coincident, namely, their phase difference θ_L is zeroed, and the maximum range is ∀90°. Accordingly, when the phases of the two signals are reverse and the zero crossing points are not coincident, the phase control is not made so that $\theta_L = 0$, and further control actions, i. e., a control action for inverting the phase of one signal is not taken. Therefore, a phase inversion control system is also provided together in the aforesaid control circuit **20L**.

The phase inversion control system has an inverting circuit **25L** and is provided in the latter part of the phase adjusting circuit **24L**. An inversion control signal only utilizes the DC component in an output obtained by comparing the phases of carriers of converted signals S_{OL}, S_{AT} with each other by a comparator (consisting of a multiplizer in this example) **25L**.

It is shown in this example that a carrier phase becomes the reverse phase in case of a positive inversion control signal, therefore the inverting circuit **25L** had better be controlled only in this case.

Accordingly, if the control of phase and polarity is taken by this control circuit **20L**, the second broadcast wave S_A is not

obtained from the synthesis circuit **16** because the respective carrier phases can be completely coincident.

Constants of the bandpass filter **21H** provided in the other control circuit **20H** is certainly selected so that the carrier (its angular frequency is (ω_a +)ω) of the third converted signal S_{CT} is obtained, if the phase and polarity of carrier are matched in this control circuit **20H**, the third broadcast wave S_C is also offset, accordingly, only the first broadcast wave S_A tuned by the synthesis circuit **16** is obtained.

As described above, the present invention is characterized by that same broadcast wave which becomes an reverse phase to adjacent channels is obtained by frequency conversion, and they are synthesized to only obtain the broadcast wave taken as channel selection destination, thus the adjacent-channel disturbance can be eliminated, therefore it enables the reception of a desired station without causing signal mixing even if a big electric power station exists in the adjacent channel.

Moreover, the aforesaid actual example is a case of AM receiver, but it is certainly also applicable to an FM receiver.

Brief Description of the Drawings

Fig. 1 is an oscillograph for description of the present invention. Fig. 2 is a system diagram of principal parts showing one example of AM receiver based on the present invention, and Fig. 3 is an oscillograph for description of its actions.

2 medium-frequency amplifier

3 synchronous detector

12, 13 reference oscillators

10M, 10L and **10H** first to third frequency converters

20H and **20L** control circuits

24H and **24L.** phase adjusting circuit

S_A - S_C broadcast waves

)ω interoffice frequency

16 synthesizer

第 1 図

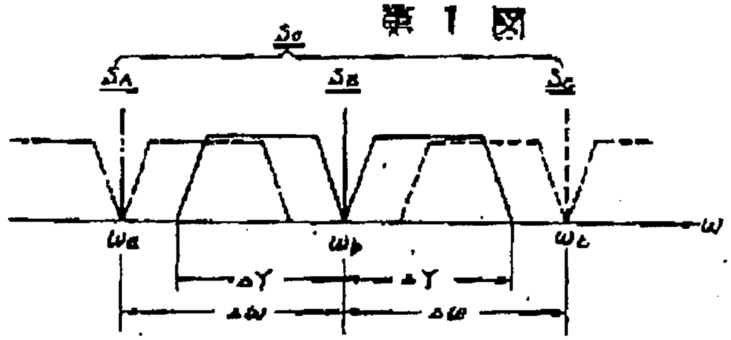

Fig. 1

第 3 図

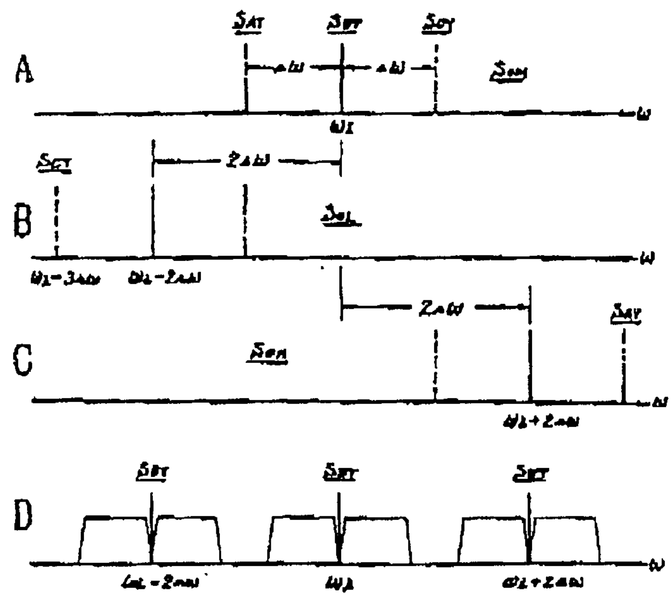

Fig. 3

/5

第 2 図

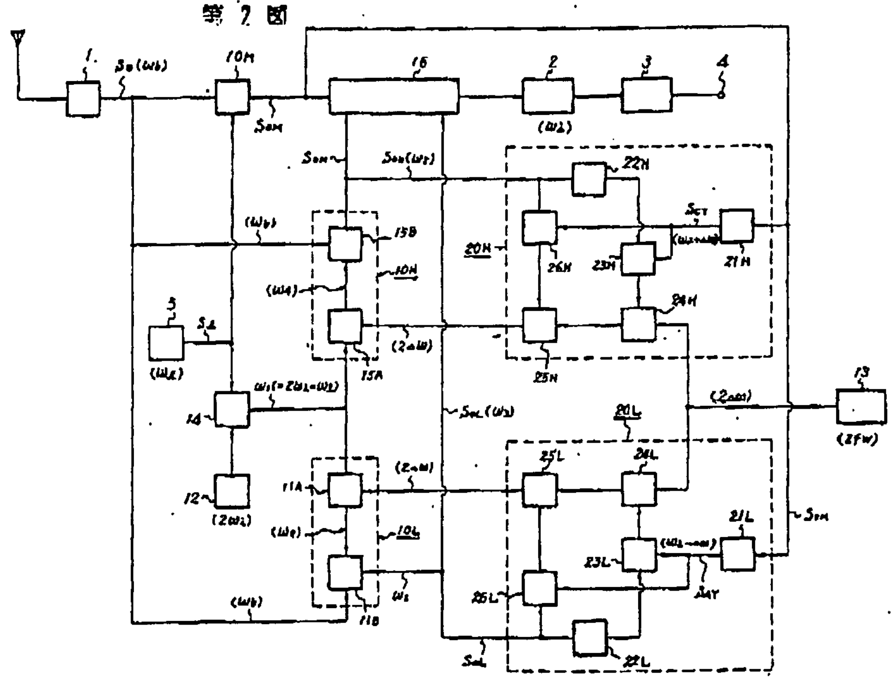

Fig. 2